Technical Aspects for the Development of an Infrastructure in a New Area

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Abstract: The infrastructure of a new area, mainly the water supply, drainage and sewerage system are vital for urbanization. While planning for these infrastructures all the aspects must be studied properly. Pumping of drainage system and sewerage system is biggest issue. This study aims at designing a collection system for a new area in such a way so as to avoid pumping of drainage and sewerage system and to develop a self-sustainable area.

Keywords: Avoid pumping of drainage and sewerage system

1. Introduction

Infrastructure of a new area is composed of public and private physical improvements such as roads, water supply, sewers, drainage, electrical grids and telecommunications. Water system works on pressure which can be created either by pumping or elevation head. If we want to develop an area for 24x7 water supplies then water pressure generated in the distribution system must be from elevation head and source water level must be maintained. Sewerage and drainage system works on pressure as well as gravity but it is always suggested to have both the system to work on gravity as pumping of drainage and sewerage system is a biggest issue in long run.

2. Objectives of Study

a) Topographical survey of the area
b) Invert level and high flood level of the existing nearby drain for excess Storm Water Disposal.
c) Determining the ground level of the road top according to Storm Water Disposal high flood level so as to avoid pumping in storm water disposal.
d) Design of underground sewage collection system and location of Sewage Treatment Plant (STP)
e) Design of underground Storm Water collection and Disposal system
f) Any municipal water supply or source of water(surface or sub surface water)
g) Design of domestic water supply system.
h) Reuse of treated wastewater in green and flushing purposes.

3. Design Considerations

In designing waste water collection, treatment and disposal system, planning generally begins from the final disposal point going backwards to give an integrated and optimum design suit the topography and the available hydraulic head.

1) Design Period

Sewerage projects may be designed normally to meet the requirements over a thirty year period after their completion. The period between design and completion should also be taken into account which should be between two to three years depending on the type and size of the project. Design periods for the project components may be designed to meet the periods mentioned below in table no 1

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Items</th>
<th>Design Period (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pumping</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Pump House(civil works)</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>Electric motors and Pumps</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>Water Treatment units if required</td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>Pipe connections to the several treatment units and other small appurtenances</td>
<td>30</td>
</tr>
<tr>
<td>6</td>
<td>Raw water and clear water conveying mains</td>
<td>30</td>
</tr>
<tr>
<td>7</td>
<td>Distribution System</td>
<td>30</td>
</tr>
</tbody>
</table>

a) Design Parameters

• Population
  The population is very important parameter because of water supply quantity is predominating.

• Rate of Water Supply
  Wastewater quantity may be assumed to be 80% of the quantity of water supply. The sewers should be designed for a minimum of 135 lpcd.

• Slope/Gradient
  Slope depends upon the topography of ground and levels. Slope is also another important parameter because the rate of flow is depends upon the amount of slope.

• Peak Factor
  The peak factor or the ratio of maximum to average flow depends upon contributory population and the following values are recommended. These peak factors will be applied to the projected population for the design year considering an average wastewater flow based on allocation.

b) Velocity

The sanitary sewer is designed to obtain adequate scouring velocities at the average or at least at the maximum flow at the beginning of the design period for a given flow and slope. Velocity is little influenced by pipe diameter. The recommended slope for minimum velocity is 0.60 metre/sec and maximum velocity is 3.00 metre/sec.
c) Pipe Size
The pipe size should be decided on the basis of ultimate design peak flow and the permissible depth of flow. The minimum diameter of public sewer may be 150 mm. In hilly areas, where extreme slope are prevalent, the size of sewer may be 100 mm

d) Depth of Cover
1 m cover on pipeline is normally sufficient to protect the pipe lines from external damage

e) Manholes
Manholes are interconnecting between two or more sewers and to provide entry of sewers. Manholes are used to building connections and junction chambers.

f) Hydraulic Design Equation
Normally, The Manning’s equation is used most commonly for the design of sanitary sewers because it is efficient, popular and fully satisfied the experimental results and same is used for this design.

The Manning’s Equation is as below,
\[ V = \frac{(1/n) \times R \times (2/3) \times S^{1/2}}{} \]
Where,
- \( V \) = Velocity in metre/sec
- \( n \) = Friction Factor
- \( = 0.011 \) (For Plastic smooth pipe)
- \( = 0.013 \) (For Cement-concrete pipe)
- \( R \) = Hydraulic Radius in metre
  \( = \frac{C/s \ area \ of \ flow \ in \ sq. \ metre}{Wetted \ perimeter \ in \ metre} \)
- \( S \) = Slope of Energy Grade Line
- Wastewater = 80 % of water supply per person

c) Determining the ground level of the road top according to Storm Water Disposal high flood level so as to avoid pumping in storm water disposal
As per the design considerations minimum cover on the pipe must be 1 m that means (99.83-(1+dia of pipe)) will be the start invert pipe of storm water drainage system. So if we design as per actual site then invert level of storm water drainage system will definitely go below the existing HFL of the drainage system. This may conclude that we have to propose the pumping for the ultimate disposal of the storm water drainage. Pumping of storm water drainage will not at all be suggested for long and efficient run of an area. So in this case we have to fill earth in order to place our pipe above HFL. Now the question arises how much filling?

So to have minimum filling required for the disposal of storm water system. Firstly storm water network will be designed and minimum ground level at different locations must be calculated considering all the design criteria.
All the start and stop node is marked and catchment area of each drain is determined and discharge of each drain is calculated. To carry the calculated discharge pipe carrying capacity is calculated so as to achieve minimum self-cleaning velocity and maintaining d/D ratio. In this way we will get minimum ground level required for the road in order to avoid pumping.

d) Design of underground sewage collection system and location of Sewage Treatment Plant (STP)

As per the HUDA norms, total population of the site is calculated:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Usage Type</th>
<th>Total Number</th>
<th>Total Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Residential</td>
<td>128</td>
<td>population @13.5 person per plot=1728</td>
</tr>
<tr>
<td>2</td>
<td>Community Facility</td>
<td>1</td>
<td>population @10 person per sqm,FAR=1=282</td>
</tr>
<tr>
<td>3</td>
<td>Commercial</td>
<td>1</td>
<td>population @10 person per sqm,FAR=1.75=195</td>
</tr>
<tr>
<td>3.1</td>
<td>Commercial Visitors @ 75%</td>
<td>146</td>
<td>98.93</td>
</tr>
<tr>
<td>3.2</td>
<td>Commercial Retailers @ 25%</td>
<td>49</td>
<td>98.95</td>
</tr>
</tbody>
</table>

Based on above suggested ground level sewage system must be designed and location of STP will be selected. As this site is very small so phytoremediation treatment based is proposed.

e) Design of underground Storm Water collection and Disposal system

As the water level of this area is very up so it is proposed to recharge the groundwater as much as possible. So all the storm water is separately collected and then storm water will be passed through oil and grease trap then desilting chamber and finally to rain water harvesting pit and overflow of the RWH Pit will be further connected to nearby existing drain. Network for carrying the storm water is designed.
based on the above said design criteria and considering above proposed ground level.

f) Any municipal water supply or source of water(surface or sub surface water)

Another important aspect is to find the source of water. In this site there is a scarcity of water still municipal water supply is available. So main source of water supply is municipal water supply but 2 tubewell is proposed for supplying water in emergency period. The pressure in municipal water pipeline is 10 m only. There are G+3 houses i.e. 22 m head is required at terminal point but the pressure in the pipeline is less. So UGT is proposed to store water and further water is pumped in OHT having 25 m staging height and further water will be supplied through distributed pipeline.

g) Design of domestic water supply system

As there is scarcity of water in this area so one day storage of water is suggested here. Water demand is calculated as shown below:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Usage Type</th>
<th>Water Requirement (in lpcd)</th>
<th>Water Requirement (in kld)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Residential</td>
<td>90</td>
<td>155.520</td>
</tr>
<tr>
<td>2</td>
<td>Community Facility</td>
<td>15</td>
<td>4.230</td>
</tr>
<tr>
<td>3</td>
<td>Commercial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Commercial Visitors @ 75%</td>
<td>15</td>
<td>2.194</td>
</tr>
<tr>
<td>3.2</td>
<td>Commercial Retailers @ 25%</td>
<td>45</td>
<td>2.194</td>
</tr>
<tr>
<td></td>
<td>Total Water Demand</td>
<td>164.138</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adding 15% of UFW</td>
<td>24.621</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grand Total Water Demand</td>
<td>188.758</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Total Fire demand</td>
<td>46.957</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Considering fire demand @ 8 hr</td>
<td>15.652</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grand Total Water Demand</td>
<td>251.368</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Capacity of Underground Tank</td>
<td>125.000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Capacity of Overhead Tank</td>
<td>125.000</td>
<td></td>
</tr>
</tbody>
</table>

In order to minimize the losses in the distribution system, it is proposed to lay the pipeline in loop.

h) Reuse of treated wastewater in green and flushing purposes

It is proposed to reuse the treated waste water in green and flushing purposes so the domestic water demand is reduced. Refuse generated from the STP will be used as manure in the green area.

After doing all the above said design further all the network will be superimposed on single drawing so as to check all the crossing of pipeline and final invert levels of the pipeline will be executed.

5. Conclusion

From the above said method we can conclude that by this method of designing any new site we can avoid pumping in the drainage system and minimum filling of earth required for the site will be calculated and we can plan accordingly rest of our infrastructure facilities.

References